

APPLICATION OF THERMAL INFRARED MULTIBAND SCANNER (TIMS) DATA
TO MAPPING OF PLUTONIC AND STRATIFIED ROCK ASSEMBLAGES
IN ACCRETED TERRAINS OF THE NORTHERN SIERRA, CALIFORNIA

James V. Taranik
David Davis
Marcus Borengasser

Department of Geological Sciences
Mackay School of Mines
University of Nevada-Reno

Summary

TIMS data were acquired over the Donner Pass area in California on September 12, 1985. The higher peaks in the area approach 9,200 feet in elevation, while the canyon of the north fork of the American River is only 3000 feet in elevation. The flight altitude above mean terrain was 34,000 feet and the data were acquired at approximately 1330 local time (1930 IRIG). There is 10 to 30 percent vegetative cover in much of the area, although 100% vegetative cover is present in meadows and where soils have developed over metamorphic rocks and capping volcanics. The vegetation is dominated by conifers, although manzanita and other shrubs are present in areas where soils have developed. TIMS data contain noise patterns which cut across scan lines diagonally.

TIMS data were analyzed using both photointerpretative and digital processing techniques. The Jet Propulsion Laboratory produced color images using a decorrelation contrast stretch technique. Initial work was conducted with the JPL photographic prints, although when the original negative was obtained, the image data was printed at 1:40,000 scale for field use. A VAX 11/780 ESL IDIMS image analysis system was used to analyze specific areas at 512 by 512 image resolution. Karhuen-Loeve transformations were utilized to display variations in radiant spectral emittance. The images were processed according to the recipe developed by the image processing laboratory at JPL. Bands 1, 3, and 5 were selected for the 512 by 512 area. The eigenvectors were calculated for these bands and used in the transformation. The raw principal component images were contrast enhanced using a linear contrast stretch. The enhanced images were united to form a single image on disk. The eigenvectors of the principal component images were calculated and were used to again transform the images. The new principal component images were color encoded so that the image correlated with topography (the one with the most variance) was assigned the color green. The second principal component was assigned the color red and the third principal component was assigned the color blue. The resultant image closely approximated the images produced by JPL. The second and third components appeared to display variations in radiant spectral emittance related to rock composition. The third principal component image largely displayed noise in the image. Only a small portion of the study area has now been field checked, but preliminary analysis has shown that variations in the red colors on the imagery seem to display variation in the silica content of rock materials throughout the area.

The study area lies east of an extensive Mesozoic fault zone that contains large slices of Paleozoic ultramafic rocks and locally metasedimentary rocks. The accreted Paleozoic and Mesozoic rock assemblages have been intruded by plutonic rocks of the Sierra Nevada batholith and are locally capped by Tertiary and Quaternary volcanic rocks. The oldest known rocks of the region belong to the Shoo Fly Complex and the various granitic bodies that were emplaced during Paleozoic time. Some of the granitic bodies are coeval and related to an overlying volcanic rock sequence that ranges in age from Late Devonian to Permian, Schweickert, et. al., (1984). The overlying volcanic sequence is now thought to be the product of a Paleozoic island arc system that was transported from its place of origin and collided with the western edge of North America, Schweickert, et. al., (1984).

The Shoo Fly Complex has been subdivided by Schweickert, Harwood, Girty and Hanson, (1984), into at least four discrete thrust bound units, or allochthons, that were emplaced prior to Devonian time:

1. The Lang-Halsted Sequence. Consists of phyllite and quartzose sandstone with chert and marble.
2. The Duncan Peak Allochthon. Consists mostly of rhythmic, radiolarian and sponge spicule bearing chert and shale with local quartzose sandstone.
3. The Culbertson Lake Allochthon. Vesicular pillow basalt, basaltic breccia, and massive basalt overlain by rhythmically bedded radiolarian and sponge spicule bearing chert and quartz to arkosic sandstones.
4. The Sierra City Melange. Consists of lenses of sheared serpentinite, gabbro, pillowed and massive basalt, ribbon chert, sandstone and small blocks of dolomite.

These assemblages of allochthonous units were elevated as the arc-continent collision progressed and they were probably beveled by wave attack, thus creating a great unconformity, Schweickert, et. al., (1984). A Paleozoic pyroclastic sequence overlies the Shoo Fly Complex and consists of 8 km. of marine pyroclastic and epiclastic deposits, Schweickert, et. al., (1984). The Pyroclastic Sequence consists of the following lithologies:

1. Grizzly Sierra Buttes Formation, Taylor Formation and lower part of the Peale Formation. Coarse conglomerate, sandstone and argillite which contain chert, quartzite and limestone. Rhyolitic to dacitic tuff, tuff-breccia, and ash flows with black phosphatic chert. Andesitic tuffs and breccias. These rocks are intruded by coeval hypabyssal intrusions that range in composition from andesitic to silicic.
2. The upper Peale Formation. Chert, slate, breccia and tuffaceous material.
3. Goodhue and Reeve Formations. Basalt, basaltic andesite, andesitic breccia containing red chert, tuff, pillow lava and subaerial flows.

The Mesozoic sequence consists of upper Triassic Limestone, the Sailor Canyon Formation which is composed of stratified tuffaceous siltstone and sandstone with minor interbeds of lapilli tuff, and an unnamed volcanic breccia of andesitic composition. The entire sequence of Paleozoic through Jurassic rocks was intruded by batholiths of Jurassic to Cretaceous age and that ranged in composition from granitic to granodioritic.

Preliminary image interpretation and field analysis has confirmed that TIMS image data displays the chert units and silicic volcanics as bright red. The imagery appears to display zoning in the batholithic and hypabyssal intrusive rocks, although this has not been field checked at this time. Rocks which appear to be more dioritic in composition appear purple on the imagery, while rocks more granitic in composition appear shades of red and pink. Areas that have more than 40% vegetative cover appear green on the imagery.

References

Schwieckert, R. A., et. al., 1984, Tectonic development of the Northern Sierra Terrane; an accreted late Paleozoic island arc and its basement: in Western Geological Excursions, Volume 4, Geological Society of America Field Trips 1984 Annual Meeting, pp 1-65.

Presented at: TIMS User's Workshop, National Space Technology Laboratories, Bay St. Louis, Mississippi, June 18-20, 1985 sponsored by Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91109.